

Innovation and development in agricultural and food systems

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Part 1

Renewing agricultural approaches

Chapter 1

A history of innovation and its uses in agriculture

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Summary. Even though studies on innovation in agriculture are relatively new, they form part of a longer history of approaches to technical progress and transformations of the agricultural sector. This chapter explores the history of the uses of the notion of innovation in agriculture and reviews the studies in this field, focusing in particular on the contributions of economics and sociology. This history can be divided into three distinct periods: until the Second World War, the notion of innovation did not appear in the literature, even though the subject of technical progress, not included by economists in their analyses, was very present in the agricultural sciences; over the next 40 years, diffusionist approaches to innovation were applied to all sectors, including agriculture, whose modernization was supported by sociologists and economists; finally, starting in the 1980s, criticism started growing of this previous agricultural development model and was accompanied by a new way of thinking about innovation, opening up new perspectives for research on innovation in agriculture and related domains.

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The origin and the first uses of the term ‘innovation’ had nothing to do with agriculture. Nor did it have a positive or technological connotation, as it does today (Godin, 2015). This term was first used in the legal and political fields, with a subversive and negative connotation in the 17th and 18th centuries, a connotation that persisted into part of the 19th century. For example, in 1740, in the French Academy’s dictionary, innovation was defined as the ‘introduction of some novelty into a custom, into a use, into an act’. It further urged that there is ‘no need to innovate’ because ‘innovations are dangerous’. In this context, in which innovation was associated with a disruption of the established order, the first philosophers and economists who were interested in the transformations of agriculture and industry preferred to use the terms ‘improvement’ or ‘progress’ when studying technical domains or organization of labour. Such was notably the case of Smith and of Ricardo, and later of Marx, who believed technical progress to be one of the engines of economic development, or of Say, who associated it with entrepreneurship (Diemer and Laperche, 2014). It was only during the 20th century that innovation acquired a positive connotation, describing a process that generates technical or organizational changes, or in products or their uses. Innovation then became a field of research, at the interface of different scientific communities (economics, sociology, geography, management, etc.) and in multiple empirical domains, including agriculture and food. It even becomes an ideology that is inviting some criticism today (Godin and Vinck, 2017).

In this chapter, we explore how the notions of improvement and technical progress,

and subsequently of innovation, have been applied and enriched by various authors, following different currents of economics and sociology, who have studied the transformations of the agricultural and food sectors. This historical approach analyses the evolution of these notions in these sectors, with respect to three factors:

- the influence of the general progression of ideas and theories on change and innovation, especially in economics and sociology;
- the macro-economic and social developments that help create the context of the challenges facing society regarding agricultural and agrifood activities;
- the transformations of agricultural and food systems that can also influence the representations, questions and methods of those who analyse them.

We will then develop the idea that while the use of the notion of progress, and subsequently of innovation, in agriculture and food has been largely influenced by exogenous factors (general evolution of thinking on technical change, macro-economic and institutional contexts), the sector is also home to innovations whose analysis and debates enrich the more general work on this notion (Figure 1.1).

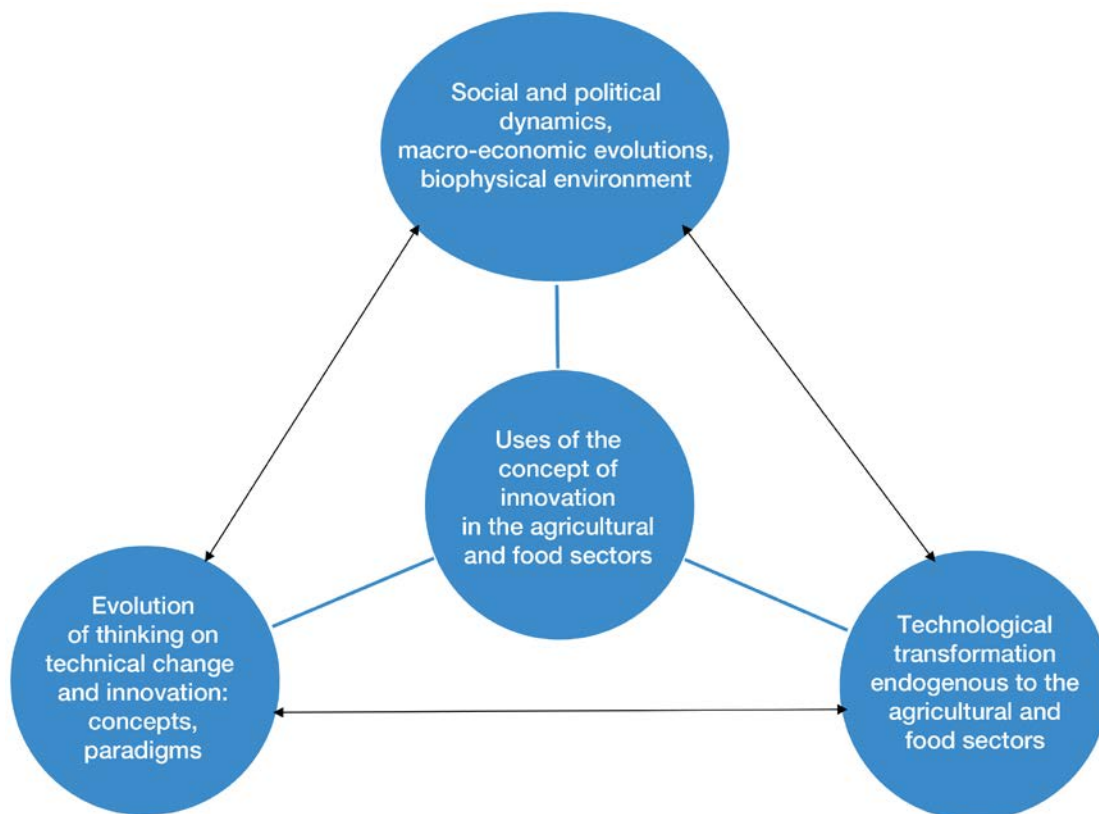


Figure 1.1. Analytical grid of innovation in agriculture.

This chapter bases itself first on a bibliographic exploration in economics and sociology, disciplines that were the first to focus on the notion of innovation in agriculture. It also relies on the work carried out by researchers of the Innovation joint research unit in France, who can be considered both witnesses to as well as actors of the uses of this notion. We have structured this chapter chronologically, distinguishing three major periods in the history of agricultural transformations and the use of the notion of innovation in agriculture. The first period covers the two centuries leading up the Second World War and the independence of many colonized

countries. During this period, the notion of innovation was not used explicitly. The topic of technical progress was, at the same time, progressively excluded by academic economists in their analyses but was affirmed by scientists of the agricultural sciences. The second period covers the 30 to 40 years after the Second World War, during which the notion of innovation, promoted by Schumpeter (1934), was mobilized in all sectors, especially in agriculture, whose modernization was supported by sociologists and economists. Starting in the 1980s, the third period was marked both by growing criticism of this previous agricultural development model and by a new way of thinking about innovation – even going as far as to criticize the notion – in economics as well as in sociology. It is opening up new perspectives on the use of the notion of innovation in agriculture.

6. Two centuries of agricultural revolutions without any reference to innovation

6.1. The gradual transformation of agriculture at the time of industrialization

European societies in the 18th and 19th centuries still suffered from food shortages (at least until the 1850s) that challenged the effectiveness of the institutions that governed agriculture, revealed the limitations of existing techniques, and called for progress in food production and distribution. Across Europe, the period was marked by the emergence of industry, profound political changes (including the French Revolution), an increase in scientific knowledge, population and urban growth, etc. Technical changes brought about a slow agricultural revolution, differentiated according to regions and sectors, closely linked to the growth of industry and trade (Vanderpotten, 2001). A major technical change in European agriculture was the abandonment of fallowing, replaced by the cultivation of forage and legume crops⁵ (Griffon, 2017), thus reducing the need for arable land to meet food needs. The changes also concerned many other aspects: tools (ploughs, scythes, etc.), application of lime and fertilizer, drainage and irrigation, selective breeding of livestock, new crops and rotations, mechanization and motorization (threshing machines, traction engines, followed by tractors). Although mechanization of labour began in the 1850s, tractors started to be used for ploughing only much later because of the fragmentation of farms, a situation not conducive to the substitution of labour by capital.

All of these technical changes took place on the back of advances in knowledge about plant functioning and soil fertility. Agronomic research emerged during this period from the empirical outcomes of experiments undertaken by major landowners, and was subsequently carried forward by public action (Jas, 2005). These changes were mainly driven by developments exogenous to agriculture, such as the modification of the conditions of access to the commons (land), the growing demand for food, in cities as well in the countryside, the mobilization of fossil energy (coal) and of the steel and chemical industries, the growth of land and sea transport, and the expansion of international trade (Losch, 2015). This process spanned several centuries, with specific geographical variations. It was concurrent with the beginning of industry, which gradually absorbed the workforce no longer required by agriculture and which, in return, provided new technical objects for transport,

⁵ In 2014, a major innovation of agronomic research in monoculture banana plantations in the West Indies consisted of the reintroduction of the practice of fallow!

mechanization and, progressively, fertilization and crop protection. The desire to increase the productivity of agricultural labour through scientific and technical progress kept growing.

The economic exploitation of colonial territories accelerated the industrial capitalism of European countries and allowed them to appropriate new commodities (cotton, rubber) and food resources, such as sugar or coffee, at low cost. The period of colonization can also be viewed as one in which a mode of production that 'optimized' the exploitation of natural resources and human resources (forced labour and slavery) was transferred through war to other territories. A technological trajectory based on a given mode of production, especially the implementation of the model of large plantations (rubber, sugar, banana, etc.) was imposed through coercion. Colonial agriculture partly funded the capital investments that accelerated the industrialization of Western countries. In 1791, for example, the main export earnings of the French Republic were from commodities, including coffee, sugar, and cotton (Jaurès and Soboul, 1983). They financed the food (cereal) imports necessary to secure social peace in the nascent industrial, textile and mining sectors.

6.2. From physiocrats to neoclassicals: the first economists progressively excluded agricultural technical change from their analyses

These two centuries of transformation of agriculture were observed by the first economists and sometimes inspired their vision of technical progress. This was the case, in the 18th century, of physiocrats in France (led by Quesnay) who argued that investments by rich farmers, enlightened by new methods, would lead to improvements in agricultural efficiency and therefore to the creation of national wealth. Classical economists (Smith, Ricardo, Mill, Say, and others) would subsequently focus on technical change, but mainly as it concerned nascent industry – even though agriculture figured in their work (Boutillier and Laperche, 2016). For Smith, the introduction of new machines and the division of labour were the result of initiatives by economic actors (especially craftsmen), but he also believed that profound institutional and contractual changes, to which technical innovations were subordinated, were also responsible (Labini, 2007). In agriculture, he suggested, for example, establishment of long-term farming contracts to encourage investment. For his part, Ricardo (1817) identified two forms of improvement in agriculture, namely those that 'increase the productive capacity of the land' (new rotations, fertilizers, etc.) and those that 'by the perfection of the machines make it possible to obtain the same product for less labour' (the plough, the beginning of mechanization). Say compared the farmer, already dear to the physiocrats, to an entrepreneur in the agricultural industry and insisted on the links between the technical changes in agriculture and those in industry, because 'the use of machines frees men from food production, allowing them to devote themselves to other activities' (Say, quoted by Boutillier, 2004). He himself invested in the first French cotton spinning mills which used cotton imported from the colonies, illustrating how industrial progress, too, was driven by colonial agriculture. But classical economists did little to explain the conditions that were conducive to technological change and its links to scientific progress. While they noted the consequences of technical progress in agriculture, they underestimated the innovative capacities of agrarian societies, thus providing fodder to Malthusian theses which argued that famines and wars were the elements that reduced the disparity between demographic pressure and agricultural production.

Continuing this work in a critical way, Marx placed technical progress in a historical

perspective, inscribing it in the dynamics of capitalism and the evolution of social relationships. According to him, this entailed ‘an appropriation of living labour by capital’, violent for the workers and the peasants, but which appeared necessary for humanity’s progress (Marx, 1959). Kaustky (1900) developed this analysis in agriculture, arguing that the rise of the ‘mechanical, chemical and biological sciences’ led to its industrialization, and favoured large farms and the proletarianization of the peasantry. This thesis was challenged in Russia by Chayanov in the 1920s, but it was only starting in the 1960s that his ideas concerning the ability of peasant agriculture to adopt technical change found favour in the wider scientific community.

For their part, neoclassical economists (Marshall, Walras, Menger, etc.), who asserted themselves in the late 19th century and towered over the field in the 20th century, did not include technical change in their analyses. Even though it was promoted in the rhetoric, technical change was considered a variable exogenous to economic analysis, which had to limit its focus to the balances between and decisions of rational agents coordinated by the market. Technical change then became a possible cause, unstudied, of the change of the function of production of an enterprise, including of an agricultural enterprise. But since it was difficult to measure, it was not incorporated into this function of production. More oriented towards the analysis of the sectors of industry, commerce and business, or towards the construction of mathematical models, academic economists at the beginning of the 20th century ended up by no longer bothering about technical progress, especially in agriculture.

6.3. The analysis of technical change in the agricultural sciences

Although the issue of technical change in agriculture was ignored for the most part by the academic economists of the 19th century, it was, on the other hand, very present in the analyses of the first chemists, agronomists, rural economists, and historians who taught and worked in agricultural schools (Mazoyer and Rondart, 1997), were active in agrarian circles or belonged to learned societies in France, Great Britain, Germany or Russia (Robin *et al.*, 2007). Their vision was very pragmatic and positive, and was stamped with the conviction that rationality and science would lead to the development and growth of a modern agriculture (de Lavergne, 1860). This was the beginning of the agricultural sciences, based not only on observations, travel, historical studies, teachings, experiments at field stations and in laboratories, but also on many regional publications and on agricultural fairs (Jas, 2005). The technical progress resulting from the ‘alliance of science and art in cultivation of the soil’ (Grandeau, 1869, quoted by Jas, 2005) formed the core of this work and was embodied in journal titles, such as *Progrès agricole et viticole* (Agricultural and Viticultural Progress), published in Montpellier from 1884. There were debates also on the use of the very notion of innovation, which remained ambivalent and suspect, as explained by the chairman of the agricultural fair of Chartres in 1856 (quoted by Farcy, 1983): ‘Improvement and innovation! These words express two very different ideas, which is why I have great reluctance in accepting certain new machines, so extolled by some that others display completely justifiable misgivings. [...] The earth is not cultivated using a pastry-cutter approach, and some combinations, very ingenious in theory, are more admired unused, at the Centre for Arts and Crafts [in Paris], than they would be in the field, where they would have to confront unexpected obstacles.’

The analysis of technical changes was also the focus of studies that paved the way for the first rural sociologists in the early 20th century. Authors such as Weber (1904), Augé-Laribé (1905) and Bloch (1931) analysed the social and political conditions which governed the technical transformations in European agriculture (especially in France and Germany). According to these authors, technical progress in agriculture resulted from a willingness to assess and increase labour productivity. These efforts were undertaken by different categories of actors depending on the country or region (*Junker*, farmer, sharecropper, winemaker, etc.), all of whom had to contend with the weight of inherited traditions and entrenched social structures. This first sociology of technical change in agriculture also highlighted the many factors that influenced it, such as the dissemination of scientific progress via industry and education, the expansion of the market for products and inputs, institutional and political changes, and changing social needs resulting from the development of an industrial society.

It can be seen from these studies that agricultural transformations were not driven by violent disruptions in technical systems. Technical changes occurred gradually depending on economic, scientific, social and political movements. The term ‘agricultural revolution’ is therefore far from appropriate to describe this period. The true technological and industrial shift in agriculture happened mainly after the end of the Second World War.

7. Green revolutions driven by the linear and technological conception of innovation

7.1. Modernization and green revolution of agriculture during the Thirty Glorious Years⁶

The post-Second World War context created an institutional environment that placed the State at the centre of productive investments in order to quickly rebuild the foundations of global food production. Following two world wars, rural areas in Europe had become depopulated. It was a matter of ensuring food security rapidly, in light of population growth and the political risks posed by food crises. A major aspect of this reconstruction was the rapid use of technological advances generated by military investments in the war effort. Chemical work on poison gases, begun during the First World War, contributed to rapid advances in synthesizing ammonia to produce mass-market chemical fertilizers after the Second World War (Allaire and Daviron, 2017). The work on military tanks (motorization, caterpillars) led, in a few years, to the mechanization of ploughing in European agriculture. This transformation of agriculture in the industrial countries was all the more rapid since the post-war reconstruction effort increased the cost of salaried labour and forced the search for a rapid increase in agricultural labour productivity. Industry-developed models were soon applied to agriculture and activities of food processing and distribution in the quest for specialization, economies of scale and the dissemination of technological innovation. The mass consumer society in Europe and the United States could come into being only because of the many process and product innovations undertaken by companies, which would soon collectively constitute a

⁶ In France, the term ‘Les Trente Glorieuses’ (Thirty Glorious Years) refers to the 30-year period (1945 to 1975) following the Second World War which saw strong and rapid economic growth in France and other developed countries.

real agrifood industrial sector based around milk, cereals, oilseeds, and meat, whose production was sought to be strengthened at national scales (Malassis, 1979).

The State's pre-eminent role expressed itself through the drafting and adoption of ambitious agricultural policies, which intervened at several levels and across domains, to accompany agricultural modernization: protection of markets, subsidized credit, investment in infrastructure, teaching, extension, and agronomic research. In France, this policy was based on an approach of co-management with agricultural organizations in order to promote a modernized family-farm business model (Coulomb *et al.*, 1990). A little later, Western countries set up international centres for agricultural research (Gerard and Marty, 1995)⁷ in a context not only of decolonization but also of the fight to prevent the expansion of communism. This effort was also driven, in part, by popular discontent stemming from worsening poverty and food insecurity in so-called 'third world' countries. The goal of this international agricultural research effort was to increase global food production by mobilizing new green-revolution technologies, especially by growing new high-yield cereal varieties. These varieties, developed at experimental field stations, required an intensification of production systems through the use of synthetic fertilizers and pesticides. The newly independent countries that emerged from the process of decolonization also implemented favourable agricultural policies (agricultural price support, input subsidies, etc.) and created extension structures, in the words of their leaders, to train the farmers to adopt the new technologies. This technological model, supported in the 1970s and 1980s by international funding and development bodies, oriented agricultural research in developing countries towards experimentation in order to ensure the successful transfer of inventions mainly developed by the research community and industry in developed countries (Lele and Goldsmith, 1989; Raina, 2011).

This model of technical intensification of agriculture, based on the consumption of chemical inputs and fossil energy, involves significant financial investments in agriculture, which are more feasible in industrial and emerging countries (China, India, Brazil, etc.) than in developing ones. It performs well in terms of the objectives of increasing productivity in contexts where the process of production is relatively secure (reduced natural and economic risks). Its implementation in these contexts leads to the adaptation of agriculture to the requirements of industrial processing. In contrast, in contexts of low industrialization, unorganized markets, high rural densities, elevated climatic risks, low access to financing or a weak State, this model's effectiveness is much more debatable. This is especially the case in many countries in Africa and Asia, where small family farming dominates and where farmers are unable finance the purchase of inputs and equipment but cannot find work either in the industrial sector (Dorin, 2017)⁸.

7.2. The economics of innovation: from Schumpeter to industrial economists

These rapid transformations of national economies and their agriculture can be analysed on the basis of research that emphasizes the notion of innovation, with, at the forefront, the work of Schumpeter (1934). He studied how the great technological

⁷ The international centres of agricultural research at the origin of the Green Revolution were created in the 1970s.

⁸ It is interesting to note that this is the same situation that is currently found in some Asian and African countries and risks becoming more widespread in the coming decades.

transformations (steam engine, electrical energy) punctuated economic cycles with phases of ‘creative destruction’. A driver of this trend was the concentration of companies, belonging to many different industrial sectors, both upstream (agro-chemical industries) as well as downstream (agrifood industries), into oligopolistic markets. Innovation appeared as a strategic objective of firms, the ‘weapon of oligopolistic competition replacing that of prices’, and a means for perpetuating capitalism. Schumpeter noted the distinction, still valid today, between invention and innovation, by considering the entrepreneur as the central actor who combines the new technology (the invention) with the market to produce an innovation. He proposed a first typology of innovations, according to the type of the novelty concerned (product, process, raw material, market, or organization).

Several studies, including those of Schumpeter, inspired the design of the linear model of innovation and post-war public policies, which was soon extended to agriculture. Thus industrial economics research in the post-war years legitimized both public policies and the central role of the State in defining major technological choices through public procurement and large enterprises, mainly in the infrastructure and energy sectors. In the late 1970s, neoclassical economists, in turn, accepted the idea of an endogenous dynamic of technological change by introducing the role of human capital in the mechanisms of growth (Denison, 1962). This shift soon led to the replacement of the term ‘technique’ in the literature by ‘technology’.

7.3. Social sciences at the service of agricultural modernization

During these ‘Thirty Glorious Years’ of strong economic growth following the Second World War, many social scientists studied and supported technical changes in agriculture, gradually using the notion of innovation, seen above all as the adoption by farmers of new technical objects (seeds, fertilizers, pesticides, machinery, etc.) developed by the research community and industry. The disciplines of rural sociology and economics in the post-war years, first in the United States then in Europe, thus committed themselves largely to the cause of agricultural modernization (Ruttan, 1996) and the transfer of this model of development to countries of the Global South (Badouin, 1985).

Rural sociology, to begin with in the United States (Rogers, 1976), would thus provide, for more than 30 years, the analytical tools and methods to promote the dissemination of new technologies by studying obstacles to their adoption and by proposing a categorization of adopters (innovators, early adopters, followers, etc.) that is still in use today in the literature on innovation. In France, sociologists also relied on the notion of innovation to analyse obstacles to agricultural modernization and the conditions that were conducive to it, which depended on the social structures of rural societies (Mendras, 1970), the modes of engagement in collective action (Boisseau, 1982), the evolution of mechanisms of intervention (training, credit, advice, etc.) and on organizations (unions, farmers’ associations, cooperatives, etc.) driving progress in the countryside (Bodiguel, 1975).

Influenced by the evolution of the micro-economics, rural economists, on the one hand, created management tools for a modern and organized agricultural enterprise open to innovation (Chombart de Lauwe, 1949), and, on the other, mobilized econometric models to assess or account for the effects of technical change (Boussard, 1987). The farmer was thus supposed to make innovation choices as an agent optimizing an income function. These models were used for two important

purposes. The first was to orient *ex ante* technical research in experimental stations towards solutions for maximizing economic performance. The second was to model the functioning of markets in order to understand the relationships between production factor prices, product prices and the adoption of technologies in order to support the implementation of favourable agricultural policies. Economic studies on technical change were also undertaken in developing countries, in particular to measure the gaps between real productivity and potential productivity, which varied by region, and to explain the determinants of technical change. These studies generally pointed to constraints in farmers' access to inputs, capital and knowledge produced by agronomic research. Starting in the late 1970s, other studies sought to understand the rationales and practices of farmers in order to adapt the technical proposals made to them by R&D organizations (Jouve and Mercoiret, 1987).

Innovation also attracted a critical appraisal, inspired by Marxism, by rural economists and sociologists in several countries (Coulomb *et al.*, 1990), but their analyses focused more on the evolution of labour relationships and agrarian structures than on innovation itself. Innovation was generally seen as a means for spreading capitalism, in the countries of the Global North as well as those in the Global South, or for the quasi-integration of agriculture into industrial sectors.

During the Thirty Glorious Years, the notion of innovation thus spread in the scientific communities that progressively came to constitute the disciplines of rural and agricultural economics and sociology, which accompanied and supported agricultural modernization in the Global North and in the Global South. Coupled with a fairly consensual view of progress and development in agriculture (and also in the food sector), studies on innovation referred to Schumpeter (more cited however in research on industrial sectors) and were marked by a diffusionist and pragmatic vision, in line with the development challenges of modern and postcolonial societies.

8. A fresh look at the notion of innovation in the face of agricultural and food transitions

8.1. From the crisis of the productivist model to new approaches to innovation

The development model of the Thirty Glorious Years began to be called into question as early as in the late 1960s, marking the emergence of a search by consumers and citizens for goods of differentiated quality. The cultural crisis asserted itself in the 1970s, driven by social movements that questioned the productivist model and the willingness to let corporate interests dictate lifestyles of entire populations (Touraine, 1978). A new societal model was sought to be built around issues concerning the environment, identity, autonomy, and self-management practices. This cultural crisis was concurrent with repeated and increasingly intense economic crises that occurred as early as the 1980s and that would culminate in the financial crisis of 2008. This succession of crises has to be seen in the context of the very many environmental and social externalities of the economic growth model of the Thirty Glorious Years that was based on industrialization and global expansion of firms: accelerated depletion of stocks of natural resources (fossil fuels, water reserves, phosphates), biodiversity erosion, climate change, structural increase in social inequalities, and health and environmental crises linked to the use of synthetic inputs. Agricultural and food issues began gaining an increasing importance in these condemnations and in political debates about the planet's evolution and the innovations likely to help meet global challenges (see Chapter 2). The reorientation

of agricultural policies in the United States, and especially in Europe, starting in the late 1980s, largely reflects these concerns, as does the change in the tenor of debates in international institutions and in their development goals (McIntyre *et al.*, 2009). At the same time, the assertion of new forms of agrarian capitalism, especially in South America and Southeast Asia, not only allowed the continuation of the agro-industrial model, but also strengthened its criticism, particularly from peasant and agroecology movements (Allaire and Daviron, 2017). The difficulties of the technological transposition of the Green Revolution to Africa also showed that the industrialization of agriculture cannot be exported to the entire world and that other ways of development would have to be found. Thus, the work of development economists in contexts of pressure on natural resources and demographic pressure emphasized the innovative capacities of agrarian societies that derived value from the productive potential of their ecosystems (Boserup, 1981).

More broadly, the crises that societies have been experiencing, especially since the 1980s, have forced companies to revamp their growth models. On the one hand, they are now being encouraged to take into account the social conditions of innovation (internally and in their environment) and, on the other, they are being called upon to invest, beyond or alongside technological innovations, in organizational innovations and intangible investments in order to become part of the new economies of quality, knowledge and services (Gadrey, 1992; Cohendet *et al.*, 1998). Agribusiness companies illustrate this trend (Rastoin, 2000). In this context, agronomic research is now including new approaches to innovation. In France, at the National Institute of Agricultural Research (INRA), this trend was embodied in particular in the multidisciplinary and participatory work of its 'Agrarian Systems and Development' (SAD) department, set up in 1979 (Cornu *et al.*, 2017). In tropical countries, it is being reflected, in particular, in the increasing use of the term 'agroecology', mobilized initially to characterize food crop production systems (Altieri, 1995; Caplat, 2012). This notion was also used in research studies in the mid-2000s as a basis for the concepts of sustainable⁹ or ecological intensification and to propose other ways of intensification in situations with degrading resources (Griffon, 2006). Agricultural research policies and institutions in some countries (France and Brazil, for example) would go on to use this notion more widely to encourage an improved compliance of agriculture with ecological principles.

During this period, the diffusionist paradigm of innovation was thus discarded or reconfigured, opening the way to a diversity of approaches to innovation in the entire production system (industry, agriculture, services) and in the construction of new links between agriculture and food and/or between agriculture and the environment.

8.2. The increase in research on innovation in economics

Economists have reacted to these social upheavals by increasing the amount of research on innovation. No doubt, many authors still continue to approach innovation as a part or an extension of neoclassical economics, not as a process but as a (new) factor of production for the firm, associated with investments in research and

⁹ In this book, the terms 'sustainable' and 'sustainability' will be used in a restricted sense to characterize a process, a system, or a sector of activity, among others, which are developed and function with respect for sustainable development ('development that meets the needs of the present without compromising the ability of future generations to meet their own needs,' as defined by the 1987 United Nations Brundtland Commission).

development, and tradable on a market in which technologies are protected by patents. But the diffusionist paradigm was called into question in the 1980s by other economists, who propose instead an evolutionist approach to innovation (Nelson and Winter, 2002; Dosi, 1993). By making analogies with biology, they emphasize how economic decision models are adaptive. Thus, the adoption of a technology is seen as the result of a gradual process, based on interactions internal and external to the company, which culminates in a selection of the most appropriate innovations. The economic problem lies in the definition and implementation of the firms' capabilities, procedures and decision-making rules to innovate and change their routines. Evolutionary economics is thus built not only around concepts of routine and innovation, but also around technological paradigms and path dependence¹⁰. This evolutionary approach has become so dominant in the economics of innovation and technical change that it has led to a new focus of the research community, on 'Innovation Studies' (Martin, 2012). In this framework, innovation processes are also analysed through the concept of the innovation system, which allows the business strategies, institutions, networks and knowledge dynamics that determine and condition innovation at a national, regional or sectoral level to be studied together (Spielman, 2006).

By helping determine the conditions conducive to innovation and the effects of its various categories, the notion of innovation also began to be used in economic currents other than Innovation Studies:

- research on industrial districts (Becattini, 2004), localized production systems, clusters and innovative environments thus highlighted the importance of local interactions and proximity (Pecqueur and Zimmerman, 2004);
- research on the neo-institutional economy also analysed the modes of governance of innovation and associated contracts and patents (Guellec, 2009);
- other economists, specializing in political economics, followed in Schumpeter's footsteps by showing how innovation is linked to the crises and transitions of capitalism (Boyer, 2015);
- financial economics itself views innovation as a process, proposing 'financial innovations' to support it.

8.3. Diversity of uses of the notion of innovation in agricultural and rural economics

This large body of work on innovation in economics, dominated by the evolutionary influence, is reflected in the increasing number of articles and books that use this notion of innovation to address agricultural and/or food issues. We can mention at least three types of uses (Touzard *et al.*, 2014).

First, the agriculture and agrifood sector can be considered simply as one of several empirical domains in which academic frameworks, such as evolutionary or neo-institutionalist analysis, can be used to analyse innovation. This is the case in many academic studies concerning the development of national innovation strategies or the

¹⁰ The concept of path dependence conveys the idea that innovation and business performance are determined by past routines and technologies.

analysis of the emergence of a new food product or biotechnology. These visions are sometimes still close to diffusionist theses, according a key role to the research community and to the evaluation of the conditions that are conducive to the acceptability of innovations by farmers and society.

Other studies, in political economics, analyse the processes of agricultural and food innovations with a more critical and historical approach, linking them to the transformations of the sector and its relationships with the rest of the economy and society (Allaire and Daviron, 2017). The issue of the sector's specificity, its institutions and its innovations then arises, which can in return inform academic and political debates.

Finally, it is important to note the existence of analyses, often related to development actions in agriculture, which advocate more original approaches to innovation by highlighting the sector's specificities and by defending a more operational perspective of rural and agricultural economics. Innovations are associated with the particular functioning of farms, the management of externalities and local resources (land, water, landscapes, etc.), links with tourism or food supply, etc. For example, innovations pertaining to products whose quality is linked to their local origins call for approaches specific to localized agrifood systems. Similarly, the analysis of the sectoral conditions of innovation leads to the use of specific concepts such as Agricultural Innovation Systems, which urge both the Global North and the Global South to revamp the diffusionist model and reorganize agricultural research and advisory structures (Sumberg *et al.*, 2002; Temple and Compaoré Sawadogo, 2018) or which propose the inclusion of specific provisions for supporting innovation in agricultural policies.

8.4. Studies on the social dynamics of innovation in agriculture

Starting in the 1970s, the break with the diffusionist model of innovation in agriculture helped to structure several research communities in sociology. By reconnecting agriculture to the domains that innovation impacts or that constrain it (environment and food, in particular), sociology also opened up spaces of new collaborations with economics.

First, a series of studies starting in the 1970s illustrated a new approach to agriculture and the rural world, relying on popular knowledge, albeit with the risk of ideological populism. The work of Chambers *et al.* (1989), in particular, paved the way for studies rehabilitating local empirical knowledge and endogenous innovation. A major contributor to a renewal of social science research in the agricultural sector in France in the 1980s, Darré was part of this perspective. He shifted the analysis from being based on categories (researchers, farmers, etc.) to local configurations of actors (morphology of networks), more or less conducive to the collective capacities of innovation (Darré *et al.*, 1989). This shift was accompanied by the realization that one of the sources of innovation in agriculture is the fact that certain farmers belong to several social groups (multi-belonging). This result was consistent with research in the socio-anthropology of development conducted in the Global South (de Sardan, 1995).

Other research studies, also in the socio-anthropology of development, opened up another perspective by bringing back into the analysis of innovations the historical trajectory and institutional context that surround the technical and organizational changes, from macro-economic policies to micro-economic decisions of enterprises

(Chauveau *et al.*, 1999; Requier-Desjardins, 1999). This approach thus encourages exploration of how technical changes in agriculture can take different historical trajectories depending on national and local contexts.

Research into alternatives to the productivist model, both in the countries of the Global North as in those of the Global South, also encouraged another field of study that adopted a more dissenting perspective. Thus, the sociology of social movements found fertile ground, basing itself in particular on environmental initiatives. These initiatives denounced the environmental damage caused by technical progress and were analysed as building a new social movement, namely an action (and no longer a situation or category, such as a social class) aimed at transforming society, not only through protest but also through local, concrete and innovative alternatives (Touraine, 1978). These new social movements (ecology, feminism, regionalism, etc.) and associated initiatives, especially in the field of local development, helped bring out the notion of social innovation. Social innovation thus designates new innovation goals and rationales. Linked with agriculture, it took shape mainly through studies on alternative food supply chains and other local dynamics that reconnect agriculture and food in a perspective of sustainability (Seyfang and Smith, 2007). In these studies, and more generally, social innovation has been closely linked to a second notion, that of civil society, which highlights the need to take new actors of social change into account (Laville, 2014).

These initiatives have also been of interest to other practitioners and theorists of innovation, working in disciplines ranging from the sociology of innovation¹¹ to ‘science and technology studies’, who saw the opportunity to propose an alternative to the centralized model of technological innovation in the form of a distributed innovation model, open to a greater diversity of actors, non-human agents, mechanisms and novelties (Von Hippel, 2005; Joly *et al.*, 2010). Research conducted in this perspective has shown how markets and associated technologies generate focal issues of concern that lead to the emergence of ‘concerned groups’ and new socio-technical networks (Callon, 1986). These groups and networks help invent and disseminate both organizational as well as technological solutions to the identified problems.

In the agricultural sector, this emergence is contributing to the development of a new regime of production of knowledge and innovation concerning the living world. This new regime has been put into perspective, for example, through the long history of varietal innovation in France (Bonneuil and Thomas, 2009), shaken up by movements that reject genetically modified organisms and advocate instead for the use of farmer seeds. Analyses of the role played by local groups in the evolution of technical systems and by social structures at higher organizational levels (sectors, public policies, etc.) both inform and call into question research clubbed under the heading of ‘theories of transition’ (Lamine, 2012). This type of analysis is inspired by the sociology of innovation, science and technology studies, and evolutionary economics (Geels and Schott, 2007).

Finally, the analysis of innovation in the agricultural sector, or in connection with this sector, generates new collaborations between economists and sociologists around how the roles of institutions, networks and knowledge should be taken into account.

¹¹ School of thought also called ‘sociology of science and technology’, ‘translation sociology’ or even ‘actor-network theory’ depending on the authors and objects under study.

These collaborations highlight the importance of institutional and local contexts in the emergence of initiatives, especially in the case of social innovations that pertain to sustainable food production and/or local development (Chiffolleau and Prévost, 2012; Laville, 2014). They allow to deepen the analysis of the learning and coordination processes, within networks of agricultural and agrifood actors, that underpin changes in practices and the co-production of new rules and norms (Chiffolleau and Touzard, 2014). In this way, these collaborations participate in the renewal of research on innovative environments and local productive systems.

9. Conclusion: innovation in agriculture, a source of theoretical evolutions and interdisciplinarity

In this chapter, we used a historical reading to present how economics and sociology were used to analyse technical change and innovation, first in the agricultural sector and then, more recently, in the agrifood and food sectors as also in territorial development. We have shown how the thinking in these two disciplines has shifted from technical progress to different forms and acceptations of innovation by examining the transformations of agriculture, with periods during which there were divergences or convergences of ideas, of application or reformulation of approaches and issues. The influences specific to the history of these disciplines have been significant, with, for example, the distancing of neoclassical economics from the questions of technical change, followed by the reinvestment of this discipline around the contributions of Schumpeter. Nevertheless, because work on the ground has become inseparable from development issues, the agricultural sciences, followed by rural economics and sociology, have also in some cases contributed to changing the conceptual frameworks for analysing innovation, both in economics and sociology. The territorial anchoring of agrifood innovation, the importance of debates and controversies concerning modifications of the living world or food security, the agroecological transition, and the emergence of social innovations in food systems are important examples of the wide range of possible research today on innovation and are potentially sources of generic results for economics and sociology.

This review has also shown that the function of innovation in agricultural development processes has varied over time, depending on socio-historical contexts and societal demands that have influenced the content. In the post-war years, marked by the recourse to concepts developed by Schumpeter, societal demand led to the transformation of agricultural activity to rapidly increase productivity. From the 1970s and 1980s, the crisis (social, cultural, then economic) that productivist agriculture contributed to led to a widening of the aims of innovation and to the involvement of a wider range of social actors (consumers, citizens, experts, etc.) in its genesis. This new context has not only called for a diversification of approaches to innovation, in both economics and sociology, but has also encouraged collaborations between these two disciplines in order to better apprehend the various factors and effects of change.

Putting the varied use of the notion of innovation in the agricultural sector in a historical perspective thus leads us to a stimulating exercise, in which the scientific research on transformations interacts with these same transformations. This effort is a new contribution to the common ground between economics and sociology. In this sense, innovation in the agricultural sector is also an intermediate object (Vinck, 1999); it permits the meeting between disciplines and the construction of interdisciplinarity. The challenge thus is to focus the debate between the disciplines

more around innovation, going beyond just economics and sociology, by including and combining the sciences of management, geography and agronomy, which are already very present not only in the field of analysis of agricultural transformations but also in other domains, such as food and the environment, in particular.

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